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Finally, it may be said that the rudimentary tibia, when present, is directed backward in the cetaceans just as in pinnipeds, showing that if it were fully developed and prolonged it would carry the pedes far behind a vertical line drawn through the hip-joint. There is also other evidence that the inclusion of the hind limbs in the whales has occurred in much the same way as in pinnipeds, for example, the femora are adducted to a remarkable degree in *Balaena*, according to Struthers, showing that the encroachment of other parts must have been the principal cause of such adduction. The femora of *Halitherium* seem also to have been directed backward toward the flukes, according to the figures given by Lepsius.

The translocation of the pedes of cetaceans has been accomplished through an extended phyletic series and was not sudden or partially saltatory as in the case of the pelvic limbs of embryo physoclists. The translocation in the first case was due to the backward extension of the limb, outwardly carrying only the pes away from its original place, in the latter the whole limb is shifted together with the girdle. In cetaceans there has been little or no shifting of the pelvic girdle, its detachment from the vertebral column being due to the atrophy of the ilium. The extension backwards of the limbs and pedes parallel with the caudal portion of the vertebral column, obviously began in an amphibious mammalian type and has thus *gradually* brought the pedes to their present position, where they appear ontogenetically; heredity, through immediate ancestry, here, as in many other cases, greatly marring the phylogenetic record. This gradual shifting, according to the method described, completely does away with the difficulty suggested by Flower as to the helplessness of the animals during the transfer, which really began in forms already to a great extent helpless on land but certainly not in the water.

The foregoing gives the principal anatomical and embryological grounds for regarding the flukes of Cetacea as the representatives of pedes translocated backward by rotation and extension of the limb rearward into a position parallel with the tail by the process of inclusion as described above, but as it is impossible to consider the evidence in favor of this conclusion in detail in this brief abstract, those interested are referred to my illustrated memoir on the subject almost ready for publication by the U. S. Fish Commission.—*John A. Ryder.*

PSYCHOLOGY.

INTELLIGENCE OF THE LIMPET.—By far the larger number of limpets “roost” upon rocks whose only covering consists of minute green algæ and millepores, together with numerous acorn barnacles. These last are seen to be of very unequal degrees of “cleaness,” some being covered with vegetable growth, others quite white and bare. Those immediately surrounding a limpet or group

of limpets are invariably free from algæ. As might have been anticipated, *Patella* is the cause of this freedom. At low tide any one on the lookout can hear a quick, regular rasping sound in all directions, and see numerous limpets slowly crawling about. Scrutiny of any particular individual shows that the rasping noise is caused by strokes of the radula, which speedily scrapes away the incrusting algæ. Whilst "on the feed" a limpet moves steadily on, pretty much in a straight line, and continually sweeps its elongated snout from side to side, feeling out probably suitable patches whereon to graze. When such a one is discovered, it is gradually licked quite clean. If the patch happens to be the surface of a moderate-sized barnacle, the circular lip is completely spread over it, almost tempting one to believe that the crustacean is about to be "sawn out." Such, however, is not the case, "house-cleaning" being the sole end in view. Indeed, limpets are often serviceable to one another by thus clearing away esculents growing upon their shells. To secure a dinner, a good deal of licking is requisite, and perhaps this habit may help to account for the inordinate length of the tongue-ribbon. Certainly, it must be used up at a very great rate.

But this is not the only, though I believe the chief way in which the limpet feeds. Those individuals which live near large seaweeds, such as *Fucus*, feed extensively upon them, as their gnawed condition testifies. I can speak confidently in this matter, having caught more than one limpet in the act. The operation was as follows: The edge of a thick flat part of the thallus was seized by the lip (as a traveler might commence on a colossal sandwich), and being, I suppose, held firmly by the upper jaw, a semicircular "bite" was gradually excavated by successive scrapes of the radula, the edges of the bite being beveled on the under side. So far as my observations extended, limpets do not feed when covered by water, but always settle down firmly before the rising tide reaches them. The intervals between which any particular limpet feeds seem to be very irregular; but, as a rule, the largest limpets are apparently least fond of long fasts.

In regard to the second point, the locality-sense, great doubt seems to exist in the minds of naturalists as to whether limpets go back to the same place to roost. I believe the question was answered in the affirmative long since by a Mr. King, but, as far as is known to me, he did not publish any details of his observations, and this is my excuse for giving an outline of mine. Following a suggestion of Mr. Murray, I marked a number of limpets with white paint, and made corresponding marks near their "scars" with a view to "keeping my eye on them." As Dr. S. P. Woodward remarks, it seems probable from an *a priori* point of view, that limpets have a settled home, for they occupy scars, often sunk to a considerable depth, which exactly correspond to the outline of the shell. My observations, made on numerous

specimens of various sizes, completely confirm Mr. King's opinion, and the method of marking rendered cases of "mistaken identity" quite out of the question. The greatest distance from its scar at which I noticed a limpet to be, was about three feet; yet this distance, though extremely rough, and covered with barnacles, was retraversed without difficulty. The excursions from the roosting-places were made in any direction where food offered; so there was nothing like beaten tracks formed. But a limpet always returns home before the rising tide reaches it, and invariably roosts with its snout pointing in the same direction. As might be expected, this position is constant only for individuals. As the shape of the scar corresponds exactly with the shape of the shell, comfort, of course, could only be gained, and a firm hold effected by limpets roosting permanently in the same direction on their scars.

The question now arises, what sense is employed by the limpet in finding its way back to its scar? The appreciation of locality displayed is certainly, for so simply-organized an animal, very keen. The sense of sight is, evidently, out of court, for an eye like the limpet's, consisting of no more than a sensitive cup, could do little if any more than distinguish between light of different degrees of intensity. The tentacles seemed at first sight to be extremely likely organs to use for the purpose, and to decide this I excised those of two marked individuals, which were off their scars. One speedily found its way back; the other seemed confused by the operation for several days, but after that time was found on its scar. This shows a remarkable power of memory, unless the scar was found by accident, which is possible, as the individual was near home when the operation was performed.

But even in that case the scar must almost certainly have been *remembered*. Thus the tentacles do not seem to be the means by which home is returned to. The sense of smell then suggested itself, and it occurred to me that one reason why limpets keep on their scars when covered by the water was to prevent the "scent" of the track traversed from being washed off. With a view to determine this the space between a wandering limpet and its scar was carefully washed again and again with sea-water. In spite of this the limpet in question readily found its way back again. Further experiments are, however, needed, on this head, for any ordinary washing would be very ineffective compared with the prolonged soaking the tide would effect in the case of a limpet (like the one just mentioned) living some distance below high-water mark. Still some limpets live so near this last that they are covered but a very short time, and yet these remain on their scars during that time. Hence I think some other motive probably induces them to remain firmly fixed to their scars when under water. Of course they can hold on best when so fixed, and this suggests the most likely reason for the habit, *i.e.*, to avoid

being washed off the rocks by the tide. I am inclined to think that the snout plays some part in helping the limpet to get home, as this organ is extremely sensitive, and certainly plays an important part in discovering suitable food. I intend carrying on more extended observations with a view to the more complete elucidation of this puzzling question in regard to the limpet's locality-sense, but this preliminary notice may possibly be of some interest.—*J. R. Davis, in Nature for Jan. 1, 1885.*

ANTHROPOLOGY.¹

ELEMENTS OF GENERAL ANTHROPOLOGY.—Without drawing invidious comparisons, it would not be unfair to say that anthropological science is better organized in France than in any other country. The Dictionary of Anthropological Sciences, now going through the press in Paris, is just at this moment followed by a colossal work by Dr. Paul Topinard. The first volume, of 1157 pages, entitled "*Eléments d'Anthropologie générale*," relates to the history of anthropological investigations and to those special investigations which have been prosecuted upon the human body. The second part of the *Anthropologie générale* will bring together all the matter furnished by the different branches of the natural history of man, taking into account instructions furnished by accessory sciences, and will make a synthesis of these results, concluding with a discussion of man in time, his origin and his future.

The second volume of the work will be the application of the zoölogic method to the determination of all the types of the human species and of all the races. This will be denominated "*Anthropologie spéciale*."

Without spending a word in the praise of a work which speaks for itself, we will give our readers a few of the tables not accessible in any text books, but indispensable even to intelligent readers.

The first six chapters are historical, tracing with great minuteness the methods of studying man from Herodotus, Hippocrates, Aristotle and Galen down to the foundation of the Anthropological Society of Paris. The next three chapters, VII, VIII, IX, treat of the methods to employ in anthropological research. The remaining chapters are devoted to the study of the hair, nose, color of hair, eyes and skin, cephalic indices, height, brain-weight, skull-cubage, craniometry, zoölogic characters, æsthetic characters and anthropometry.

In a former number of the NATURALIST we called attention to a fact, often noticed, that the method of the formation of races is in a certain sense antizoölogical. As Professor Flower observes, the methods of the formation of species are necessarily disper-

¹ Edited by Prof. OTIS T. MASON, National Museum, Washington, D. C.